

DEVELOPMENTS IN CONCRETE PAVING TECHNIQUES

by

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Introduction

The contractor today is assuming greater responsibility in his choice of construction equipment and techniques and in meeting more exacting tolerances. He is performing self inspection for assurance of staying within specifications, economy of operations and for better relations with engineers.

Today's concrete paving contractor is taking more pride in his work than ever before. He realizes his future market depends on how well he builds his pavement. He wants his work to continue to look good, to be durable, long lasting and better riding than his competitor's project. The contractor tries to build the smoothest pavement he possibly can. Specifications should be written so as not to restrict his choice of equipment or how he chooses to build his pavement.

Engineering Design

Geometric design is becoming more reasonable. We are building wider pavements with optional construction joints. California is currently building 48-ft. wide pavements in a single pass. There should be standardization of ramp widths, elimination of variable width sections where ever possible, elimination of parabolic crowns and straight crowns retained through super elevated curves. This makes for smoother riding slabs, more economical equipment and greater production at lower cost.

We see greater use of stabilized subbases. These give a greater bearing value, permit thickness reduction of surface courses, and provide the contractor with a surface on which he can operate. This also gives him a longer construction season since he can work during inclement weather. Ordinarily he might have to shut down to prevent tearing up of unstable bases.

The weight limitations on construction hauling units (to keep in line with technical advances in equipment developments and with pavement design) places a burden on the contractor. Permission should be given the contractor to haul on the grade as necessary for construction purposes. He should have the responsibility for replacing any damaged sections. Western highway engineers and contractors can show that the few cents additional cost in subbase design and construction is more than returned in savings of the pavement construction operations. Both contractor and owner benefit.

One trend that promises a new market for concrete is towards thin continuously reinforced concrete overlays on existing pavements. Experimental projects have been built in two states and are being considered in others. Another design trend is the use of concrete paved shoulders adjacent to concrete pavements. Such shoulders have been built in Missouri metropolitan areas, Minnesota, Illinois and Iowa. Illinois has constructed experimental projects incorporating four design variations on an interstate section. The shoulders are 6-in. thick without reinforcing next to a 7-in. continuous reinforced slab. They were built with a slip-form machine of contractor design, and have grooves troweled into the surface with a corrugated float at variable spacing to serve as a warning device.

Construction Trends

Trends in concrete paving construction are motivated by one or more of the following factors:

- 1) The need to do a better job.
- 2) The desire for greater production.
- 3) Mechanization to replace high labor costs.
- 4) The desire to build better riding pavements.
- 5) Equipment to operate at closer tolerances, eliminating excessive over-runs of expensive materials.

In the following discussion it is necessary to identify the manufacturers of some pieces of equipment. This discussion is concerned more with methods than with make or manufacturer. There are generally several machines in each line capable of performing satisfactorily, any one of which could have been included.

Subbase Placing and Fine Grading

Subbases perform several functions in the construction process. When conventionally formed concrete is used, the subbase provides a stable anchor for forms and dowel baskets (where used), and an accurate surface on which to place the concrete and thus assure a proper slab thickness. With the advent of slip-form paving, subbase stability has become more important than ever before. The subbase must provide a uniformly stable, accurate grade upon which to operate the slip-form paver.

In subbase preparation, the trend has been toward larger, self-contained machines with automatic controls.

The Rex controlled fine-grading machine has finished up to 12,500 sq. yd. of cement-treated subbase per day. The Rex machine is equipped with a 14-ft. wide cutting blade which is automatically controlled from a pre-set tracing wire. For adjacent lane trimming, tracers on either side of the machine are used to obtain reference elevations from the surface previously prepared by wire profile.

The machine is capable of operating on subgrades, bases, shoulders and ramps. It is generally pulled by a D-9 tractor or equal. The guide wire is set 6 1/2 ft. out from the pavement edge, supported at 50-ft. intervals on tangents and at 25-ft. intervals on transitions.

The Ko-Cal fine grade machine is a self-propelled, self-contained unit running on four crawler units. Sensing devices operating on the taut wire control the machine both vertically and horizontally. This machine is equipped to spread two windrows of subbase material by means of V-spreaders. It has a grade-controlled strike-off blade, with a moving paddle to remove excess material to the sides. It carries two vibrating pans at the rear for consolidation. The machine spreads, fine grades and compacts in one operation. On one Colorado project it laid granular subbase at the rate of over 6,000 lin. ft. per day.

C. S. Johnson Division, Koehring Company, has developed a new subbase spreading and finishing machine. This machine runs off of wire control similar to the Ko-Cal machine. It is, however, considerably smaller and more portable than the Ko-Cal. Central mix material can be dumped directly into spreader boxes on the front of this machine. The machine then spreads the material, finishes and compacts it with the full width pan vibrator in a manner similar to the Ko-Cal principle.

A machine built by Hurst Lewis and modified by the contractor was used on the Oklahoma Turnpike project of Roberts-Western. The self-propelled machine runs on four separate crawlers. V-type blades spread the material from twin windrows placed on the subgrade. Two lines of reciprocating tines agitate the mixture to give it a uniform fluff. The material is then cut to "loose grade" with two oscillating screeds. Subbase grade accuracy is determined by the accuracy of the subgrade. Roberts-Western has placed over 19,000 sq. yd. of CTSB per day with this machine.

The Guntert-Zimmerman Finegrader has been used extensively in California for the past several years. This machine was developed for highway work from G & Z's years of successful experience on ditch lining trimmers. The Guntert and Zimmerman trimmers are capable of finishing subgrade or subbase width of from 14 to 50 ft. with a capacity of from 75 to 350 cu. yd. per hour. The machine utilizes the same electronic controls, operating off a piano wire, for elevation and alignment that are used on the G & Z slip-form paver.

Another manufacturer of ditch lining equipment, R. A. Hanson Co., Inc. has put his experience with ditch lining equipment into the highway field. This machine is known as the RAHCO HTS-24 Trimmer Spreader. The latest model has two long tracks instead of four short ones as on earlier models. It is equipped with a discharge-loading conveyor at the rear. The RAHCO Machine can spread subbase material with its two-way rotary spreading action or trim compacted subbase. The string line tracing automatic grade controls, cross level, and steering are accurate to within 1/8 in. The HTS-24 finishes a 27-ft. wide subbase. The trimmer cutter and spreading screw are 36-in. in diameter.

The most recent addition to the line of high speed, accurately-controlled, fine grading equipment is the Autograde manufactured by Construction Machinery, Inc. It was introduced last year. This is a multipurpose combination machine which can trim the subgrade, spread the subbase materials and trim the compacted subbase. All operations can be done to a tolerance of 1/16 in. The Autograder will travel from 0-300 fpm in infinitely variable speeds. The Autograder has a 30-ft. wheel base and is 28 ft. wide, mounted on four 16-in. wide Caterpillar crawler tracks. The basic components are a single two-piece 30-in. diameter rotary cutter; a 30-in. diameter helocoid screw spreader with hydrastatic transmission for rotation in either direction and tandem two-piece moldboard templates. The machine is automatically controlled for elevation by four control systems, one at each corner which operate from a neoprene string line.

Central Mix Paving

This is the area which has seen, perhaps, the greatest revolution in the past few years. More and more concrete is being mixed in portable central-mixing plants and transported to the paving site in large capacity, quick-dump, non-agitating or agitating trucks. Central plant mixing became possible with the development of highly portable, automated batching and mixing equipment, capable of turning out high quality concrete; the parallel development of special spreaders for central mix and adoption of more realistic mixing times for large drum mixers.

The cost of a central plant set-up is no greater than a conventional batch plant spread; it may be considerably less. There is usually less plant space required since there is only one stop involved. A further advantage is that several paving sites can be serviced at one time. Where specifications allow, both paving and structural projects can be furnished simultaneously from a single plant. The paving site is less congested without the paving machines, water trucks and hoses in the area of slab placement.

There is a trend toward 1 1/2 in. top size course aggregate instead of 2 1/2 in. to 3 1/2 in. top size. A more workable and better concrete is obtained. This is especially true with slip-form construction. Material handling problems are reduced and a more uniform concrete is obtained.

New specifications are provided for aggregate inspection and testing prior to incorporation into the work and as near the source as possible. These specifications also permit the use of conveying equipment in aggregate stock piling.

Mixing time on projects involving central mix paving has been reduced to 50-60 seconds without any loss in quality of the concrete. Studies made recently by the Bureau of Public Roads reveal that minimum mixing time for large central plant mixers of the tilting-drum type should be determined by plant-mixer performance tests in any case where reasonably possible, and in all cases involving 20,000 cu. yds. or more of concrete. Mixer performance test data

should be based on three concrete samples taken at the mixer from each test batch. Samples should be representative of the front, middle and rear portions of the batch at time of, or immediately prior to discharge. In no event should minimum mixing time be less than 40 seconds.

Where mixer performance tests are not made, minimum mixing time should be 75 seconds; provided that proper blending of materials during charging is obtained.

Proper adjustment essentially means correctly controlled timing of each ingredient during charging of materials into the mixer, and thorough blending of all the batch ingredients (aggregates, especially sand, cement and water).

The BPR results indicate that mixing time, per se, beyond a critical minimum is not significant in the production of quality concrete. This critical minimum mixing time is probably between 30 and 40 seconds depending on batch design and type of aggregates. In poorly adjusted plants, additional mixing time beyond the critical minimum is necessary to compensate for deficiencies in charging and blending adjustments.

It was right here in Kentucky several years ago when central mix was the key factor in a production race between competitors to pave not just a mile, but two miles a day.

A Rex Porto Paver with twin 8 cu. yd. mixers has produced more than 600 cu. yd. of paving concrete in one hour with a 60-second mix. This plant enabled Arcole Midwest Corp. of Skokie, Ill., to pave 9,132 lin. ft. of 9-in., 24-ft. wide reinforced pavement in 11-1/2 hours on the Western Kentucky Parkway. On this same turnpike the Green Construction Company of Oaktown, Indiana, used a similar Rex Porto Paver Plant to pave 10,614 lin. ft. in a 12-1/2 hour working day. Rex has recently put a 10-cu. yd. tilting-drum mixer on the market. Also available is a satellite plant with a 4-cu. yd. tilter having a capacity of 160 cu. yds. per hour.

Many contractors are locating their automatic control panels in air-conditioned trailers which also house the plant generator. While most plants have the cement batcher located over the discharge of the aggregate conveyor, some contractors have chosen to tip the cement storage bin into position above the lower end of the aggregate belt conveyor and convey the cement to the mixer on top of the aggregate.

Schultz and Lindsay Construction Co. of Fargo, N.D., used an Erie-Strayer central-mix plant with twin 8-cu. yd. tilting-drum mixers to establish the current paving record of 12,091 lin. ft. in a 15-hour working day. This was also used by the Wilson Contracting Co., New Castle, Dela., for paving the Delaware Turnpike, setting a new paving record of over a mile a day in the eastern region. A more impressive figure illustrating the high productivity of these central-mix plants is the fact that Schultz and Lindsay has exceeded a mile per day on 40 different days.

The Southwest Oklahoma Turnpike was the scene of many new developments. Cimarron-Empire have combined slip-form with still another type of central-mix plant. This plant uses a Rex Rotary (turbine) 4-1/2 cu. yd. mixer. This type of doughnut-shaped mixer is powered by a drive motor at the center.

The T. L. Smith 8-cu. yd. tilting-mixer is hydraulically driven as are the conveyor belts. The plant is equipped with a diesel engine driving three high pressure hydraulic pistons pumps and a small generator. This particular plant was used on I-94 in Wisconsin.

The most recent manufacturer to put a central mixer on the market is the Heltzel Steel Form and Iron Co. The Heltzel mixer is on the McDougal Hartmann project near Peoria, Ill., and can accommodate one or two 8 cu. yd. tilting mixers. The plant has a complete dust collecting system for mixer and batch plant. This plant can also be used for dry batch or truck mix operations. This new mixer is compatible with existing Heltzel mobile plants.

Automation is made to order for the central-mix plant. A single operator at a control panel performs all functions of charging, mixing and discharging. This automation increases capacity and ensures the control of quality concrete. Also available is the slump meter which measures the current required to turn the mixer. This meter is calculated with slump tests and gives the operator an immediate reliable check on the slump of the concrete.

Manufacturers are now putting out plants which will mix 11 cu. yd.

Batch Plants

Developments in batch plants have kept pace with progress in other areas of paving. For example, there have been many innovations to ensure batching uniformity. Improved electronic and hydraulic operation of weighing and recording equipment is activated by push-button controls. An automatic moisture meter in the sand hopper maintains a continual record of the moisture content in order to maintain uniformity. Self-erecting mobile plants are in use which can be adapted to any type of batching requirements. They are quick to dismantle and re-erect with a minimum of down-time and cost of erection.

Haul Units

The use of central-plant mix concrete for paving has triggered the need for haul units to carry the mixed concrete from plant to batching site. With low slump air-entrained concrete, this is possible with no loss in the quality of the concrete.

Until recently, specially shaped bathtub-type trucks were required. Both agitating and non-agitating types were manufactured. These units discharged either from the side or from the rear. Tri-rear axle, 12 cu. yd. agitator hauling units are now available. Central-mix hauling on recent projects has been done with ordinary truck boxes. Dump trucks become economical and practical when they can operate on stabilized subbases and discharge into spreader boxes as is

the practice in most of our Western states. One contractor has combined two Maxon Side Dump units onto a single trailer and is hauling 17 cu. yd. with one tractor.

A recent development in transit mix trucks is the Challenge "Tilter" truck-mounted mixer. A similar special unit is manufactured by Rex Chainbelt, Inc. The front end is raised by hydraulic hoist so that low slump concrete can be discharged rapidly and completely. The truck, which has a capacity of 7-1/2 cu. yd. for mixing, or 9-3/4 cu. yd. for agitation, can discharge in about 45 seconds. It can also be rapidly charged from a conveyor belt. Where used to run on the grade in front of the spreader, it has been equipped with wide flotation tires to reduce the densifying effect on the subgrade.

Spreaders

The use of central-mix paving created a need for spreading equipment specifically designed to receive concrete from trucks and spread it uniformly over the grade. At least two manufacturers have designed equipment consisting essentially of a hopper that can be loaded from either shoulder.

The Maxon spreader was the first on the market specifically designed to receive central-mixed concrete from wet-batch delivery trucks. The 12-ft. long hopper moves transversely across the grade, depositing concrete at a uniform depth. This hopper can take the full 8 cu. -yd. load carried in a side dump truck and drop it on the grade in 30 seconds.

One contractor is using an adjustable width crawler-mounted Maxon spreader in front of a slip-form in Mississippi. The machine is placing concrete over pre-set continuous reinforcing steel at rates up to 6,500 lin. ft. of 24-ft. wide pavement per day. This machine can place concrete 20-25 ft. wide at a speed of 30 ft. per minute and can be converted to form paving. Two of these spreaders have been used with a slip form machine to pave conventional mesh-dowel pavements.

The Rex Central Mix Screw Spreader has a receiving hopper on each side of the grade. Each receiving hopper has a longitudinal screw which can move the full load of the central-mix haulers to the full width transverse screw, which spreads and strikes off the concrete. Concrete can be discharged into the receiving hoppers from either side, or both sides simultaneously. Rex also has available a variable capacity hopper spreader for receiving side dump delivery.

Belt spreaders that can receive concrete from standard dump trucks operating off of the shoulder are gaining in popularity.

Box-type spreaders have been developed which receive central mix concrete from conventional dump trucks, metering and depositing concrete on the grade.

Mesh Placers

Placing of distributed steel mechanically is a very recent development that had its beginning when the mesh was taken off the shoulder or backslope where it was spread, and placed on a mesh carrier towed by a spreader. It was then just a step to developing a device to follow and force the steel into the concrete. Indications are that these machines may eliminate the need for surface vibrators; they may also eliminate the present requirements for tying the steel together.

The mesh placing machine is a development that appears to have definite advantages, not only in greater pavement production but in eliminating possible cold joints in two-course construction. The Rex mesh placer is usually mounted on the front end of a long wheel base finishing machine. Both mesh placing and finishing operations are controlled by a single operator. The sled device vibrates as well as pushes the mesh into place as the machine moves forward.

The Heltzel mesh placer is a separate machine composed of a series of grids which vibrate and push the mesh to its proper depth. The mesh is depressed in 15-ft. long sections from the slab surface with the machine standing at rest on the side forms. In addition to these mesh machines, equipment is also available for vibrating continuous reinforcing bars into proper position.

Dowel Placers

Dowel placing machines were first developed several years ago. The speed-up of paving operations in recent years has again turned attention to their use. Visual surveys of 28 projects indicate that mechanically placed dowels perform at least as well as, in most instances better than conventional dowel basket construction. The saving in elimination of dowel supporting units has been estimated at about \$3,000 per mile of 24-ft. slab. This unit is another link in the chain of automated operations which could well mark the standard paving job of the future.

The Heltzel dowel placing machine has been used successfully in twelve states. Dowels are set in a slot device which, when lowered into the fresh concrete, permit them to be placed in exact position with minimum disturbance to the concrete. This operation eliminates the problem of getting concrete underneath the dowels. An Oregon contractor has also successfully used his own shop-made dowel and tiebar placing machine for several years.

Jointing and Curing

In California the polyethylene strip is used for jointing longitudinally. The material is automatically placed into the top of the concrete from a roller carried on the slip-form machine.

A recent innovation in sealing, which has been tried experimentally, is the neoprene compression seal. If it can be placed properly and permanently, it may fill the dire need for a durable, elastic seal that will not fail in cohesion or adhesion after a few seasons of use. More experience with these pre-formed neoprene sealers is needed before their worth can be properly evaluated.

The techniques of forming joints in concrete were revolutionized by the development of diamond or silicone carbide blades for cutting both transverse contraction and longitudinal center joints. Sawing results in better riding pavement, more durable joints and a reduction in hand-finishing. Today we have a wide variety of saws, from single blade to multiple blade span, for cutting contraction joints.

Increased power has improved efficiency of saws, resulting in longer blade life and greater economy. Originally, all saws were water-cooled. Today, whenever silicone carbide abrasive blades are used, sawing can be done dry, eliminating the need for water trailers or trucks, and permitting earlier cutting without damage to the concrete. Self-propelled span saws, in which four or more blades are used, permit joint sawing at a rate compatible to present paving productions of a mile or two in one working day. Saws for cutting longitudinal center joints are now commonly self-propelled and self-guided. Frequently these saws also contain a train or series of saw blades to accomplish more economical sawing to the prescribed depth. In some cases, to make joint sealing more effective, highway departments are now specifying a step-down type joint with a wider groove at the surface in order to obtain a better shape factor for a more effective seal. This is normally done by a series of two or more saws in tandem for either longitudinal or transverse joints.

Transverse construction joints have always been a problem when required to be placed at the normal joint spacing. Several states have reduced this problem by locating the transverse construction joint approximately at the panel mid-point and using a simple butt-type joint with deformed tie bars of the same diameter as specified for dowels. This gives more leeway in joint location and eliminates all the problems of having dowels properly aligned.

Longitudinal construction joints are being simplified to permit uninterrupted paving of the main line. Dog ear widenings at ramp entrances and exits are being eliminated.

With increased production from batching and mixing plants and paving equipment, other operations also had to keep pace. High-speed curing equipment is now available which will permit application at a prescribed rate on both the surface and the slab edges at speeds up to 60 ft. per minute. These machines can operate on side forms, or, if slip-form pavers are used, on rubber tires straddling the pavement.

Slip Form Paving

While conventional paving methods have been undergoing a gradual evolution during the past decade, the real evolution in paving techniques has been the development and the use of the slip-form paver. Since the first experiment on a county road in 1949, and the first production model slip-form paver in 1954, slip-form pavers have come into use in more than half of the states. They are used to build hundreds of miles of pavements each year. In Iowa alone in the

past ten years, more than 1,000 miles of two-lane pavement has been built using the slip-form method. Practically all of the states in the western half of the country are using slip-form exclusively. In Illinois contractors are switching to slip-form at a rapid pace. Colorado, Oklahoma and California are now building large mileages, and use of slip-form has spread from coast to coast. The slip-form technique is no longer experimental. The acceptability and advantages of this method of concrete pavement construction have been proven. 19 1/2 million sq. yds. of concrete pavement were placed with slip-form equipment in 1965.

The most significant break-through occurred in 1964 when the slip-form was used in several states where mesh dowel design is required. The first project was constructed in Oklahoma on Interstate 40. Two Rex slip-form machines were used in tandem to pave five miles of dual 24-ft. wide, 9-in. thick concrete pavement. The lead slip-form paver struck off the 6-1/2 in. bottom course of concrete dumped on the grade in front of the machine by a dual drum and a tri-batch mixer. The frame of the lead slip-form machine carried the mesh, which was simply pulled off by laborers and dropped into place on the surface of the bottom 6-1/2 in. course. Offsets 2 in. thick were attached to the inside of the sliding forms. This 2-in. reduction in width on each side permitted the second slip-form paver to clear the edges of the bottom course with ease. The rear machine was a conventional Rex Slip-Form Paver. A dual-drum paver deposited concrete on top of the mesh in front of the second paver. The 2-1/2 in. top course, plus the filled-out bottom course, was thoroughly vibrated and extruded to a smooth 9-in. thick, full 24-ft. wide pavement.

A similar project was constructed in Iowa on I-80 in 1964. In Oklahoma the mesh was carried on the frame of the first machine, and in Iowa it was stacked along the right-of-way and carried in from the shoulder.

The Quad City Construction Co., pioneer of slip-form paving in Iowa, developed its own spreading device coupled with a new Rex Slip-Form Paver and central-mix plant to pave its contract on I-80 in eastern Iowa. A 45-ft. section of heavy special-shaped form was fastened to the front corners of the paver. A split, reversible screw spreader mounted on crawler tracks and guided by the 45-ft. form sections struck off the concrete for the first course. The crawler-mounted screw spreader was self-propelled and could move forward or backward within the 45-ft. length of guide forms. The mesh was laid out on the subbase ahead of the paving operation. Laborers passed the sheets of mesh over the screw spreader so that the mesh was placed directly on the struck-off first lift of concrete. Quad City this year paved 85 miles of county and secondary roads in Iowa with one Rex Slip-Form Paver and two 8 cu. yd. Rex Central Mix Plants. The plants were leap-frogged from one site to the next to keep the slip-form paver in steady use.

Specifications should permit the contractor to choose whether he'll use two machines or one and vibrate the steel in from the surface. Tell him what result you want and let him work out the details of how to do it. You'll get a better job and it will cost less.

The latest Rex Slip-Form Paver incorporates optional wire control, screw spreader, a 5-1/2 ft. deep extrusion meter, and is heavier than the older models.

There is a difference of opinion as to where the electronic controls should be used. Some contractors use the controls on just the finished pavement, some on just the subbase and still others on both subbase and finished slab. Specifications should not restrict the contractor, but give him freedom of choice in selecting controls and equipment.

Contractors paved not only the main line but also the ramps on projects in Wyoming. Another contractor successfully placed integral-curb ramps with its machine on an interchange of an express-way near Lawton, Oklahoma.

Texas is having success with slip-form on the state's continuous reinforced Interstate projects. Texas contractors are building a smoother pavement with slip-form methods than they were able to obtain with formed construction. One Texas contractor has used his slip-form to successfully construct a continuously reinforced concrete resurfacing over an asphalt pavement.

Continuously reinforced pavements have also been built in Mississippi with a Rex machine and in Illinois with both Rex and Guntert and Zimmerman slip-form pavers.

The first airfield job to use slip-form pavers in the U. S. was at Hillsgrove, Airport in Providence, R. I., in 1958, when the circular parking apron was paved. The apron is 1,300 ft. long and 300 ft. wide, 8 and 10 in. thick. In 1966 a Guntert & Zimmerman machine was used to pave the new county airport in Sacramento, California.

France has had more experience with building multiple-lane airfield pavements with slip-form equipment. A completely new airport project was built near Brest, France, where the Rex Slip-Form Paver was used to pave multiple lanes for the main runway, the secondary runway, taxiways, and parking aprons.

A Guntert & Zimmerman Slip-Form Paver was used to construct a new taxiway at Orly Airport, Paris, France. These machines had previously been used successfully on highway pavements in France.

It is no longer an uncommon sight to see a 36-ft. wide pavement being slip-formed in one pass without side forms. Contractors like the cost savings resulting from just one pass rather than two on a 36-ft. pavement. Many of these pavement designs have the two outside lanes 9-in. thick and the inside lane 8-in. thick. The 1-in. difference is built right into the cement-treated subbase and subgrade. These 36-ft. slip-form pavers are compatible with all types of hauling units.

In 1965, near Del Mar, Calif., the first 48-ft. wide highway pavement was placed in one pass with a Guntert-Zimmerman machine.

The Blaw-Knox Company has several slip-form pavers operating in California, placing 24, 36 and 48 ft. wide slabs.

A modified Blaw-Knox slip-form paver has been successfully used by Kasler-Ball Construction Co. of California to pave a 48-ft. project near Banning, California. The Kasler-Ball paver easily handles 500 cu. yds. of concrete hourly from twin Rex 8 cu. yd. Central Mixers. A California profilograph reading average from 1.2 to 1.4-in. per mile. California specifies a smoothness index of 7-in. per mile.

The electronic control devices for both horizontal and vertical alignment have resulted in grade accuracy and surface smoothness never before attained. The same guide wire can be used to trim the subgrade, finish the subbase, and control the pavement elevation. Some of the excellent riding pavements being built with the slip-form are constructed without the aid of trailing forms, or without hand finishing behind the machines. One of the main advantages of slip-form paving is that the concrete is confined into its final form at high densities within a comparatively small space and requires only a minimum, if any, manipulation of the surface of the slab behind the slip-form. Any additional working of the surface of the slip-form machine only produces a less durable concrete surface.

Many contractors, particularly in the West, are using a pipe float for final finishing. The pipe float which is either self-propelled or pulled by hand operates diagonally across the slab. The pipe float action develops a small amount of grout to eliminate minor irregularities and produces a uniform surface.

There are now several new manufacturers entering the slip-form paver market.

The RAHCO Slip-Form Paver, manufactured by R. A. Hanson Co., Inc. has been used in California on an Interstate project near Burlington, Colorado.

Koehring-Johnson has a pilot model machine which paved a four and a half-mile project in Oklahoma in 1963 and was used on several test projects in Illinois in 1964. This machine was used in North Carolina during the '66 construction season. It operates from a single wire control for alignment, elevation and cross slope.

The latest of the slip-form manufacturers is the Heltzel Steel Form and Iron Company. This paver will have reciprocating screeds and pan float similar to the combination finisher float operation. A separate complimentary spreading unit will be available to permit single or two-course construction for reinforced pavements. This machine was used on a pilot project in Iowa this past season.

Summary

The future for concrete pavement construction looks bright indeed. Complete automation is removing the element of human error to produce smoother, more durable concrete pavements with greater economy than ever thought possible. Now it is up to engineers and contractors to see that these new techniques and equipment are used where ever feasible. Specifications must permit these trends in construction to benefit both the riding public and the taxpayer.